

Tridyne Gas Reactor Sizing

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Tridyne is a stable mixture of hydrogen, oxygen, and an inert gas such as helium or nitrogen. In this mixture, the inert gas is the primary constituent, usually 90 to 95 percent by volume. Tridyne's usefulness stems from the ability of hydrogen and oxygen to react in the presence of a catalyst to form water. As this reaction proceeds, it releases thermal energy causing the Tridyne mixture to warm and expand. Tridyne shows promise for two potential spacecraft propulsion applications:

- As a pressurant gas for pressurizing propellant tanks; and
- As a propellant for attitude control thrusters.

Tridyne offers the advantages of reducing spacecraft weight by eliminating heat exchangers and/or reducing the storage volume required for pressurant gases. To

investigate these potential uses, NASA and the U.S. Army are conducting a joint research program to study the chemical reaction characteristics and potential uses of Tridyne gas.

Tridyne research began in the mid-1960's when Rocketdyne performed a series of experiments designed to reduce the weight of a propulsion system's pressurization subsystem.¹ The approach was to reduce the required pressurant mass by increasing its temperature. The reduction in mass also led to reductions in storage volume of gas and hence mass of the storage tank. Later experiments addressed the use of Tridyne as a monopropellant for attitude control thrusters.^{2,3} Catalyst beds were sized empirically rather than analytically—an approach which makes it difficult to scale bed sizes for other applications.

The purpose of NASA's ongoing research is to bring the Tridyne concept to a higher level of technology readiness by determining reaction rate coefficients for use in reactor sizing.

The Tridyne study is organized into four phases. Using the apparatus shown in figure 39, Phase I will compare the activity of candidate catalysts by measuring temperature increase across the catalyst bed as a function of flow rate and inlet temperature. The selected catalyst will then become the subject of Phase II, which will evaluate the reaction rate coefficient as a function of temperature for a range of mass flow rates. Phase III will seek to estimate the expulsion efficiency for a pressurization system using Tridyne as a pressurant. Finally, Phase IV will examine thruster performance using a truncated nozzle installed immediately downstream of the catalyst bed.

At the time of this writing, the test article is 98 percent complete. Testing is currently projected to begin and conclude in the summer of 1997.

As described above, the primary benefits of Tridyne are expected to be mass reductions for spacecraft pressurization systems and decreased risks associated with handling storable monopropellants. The decreased

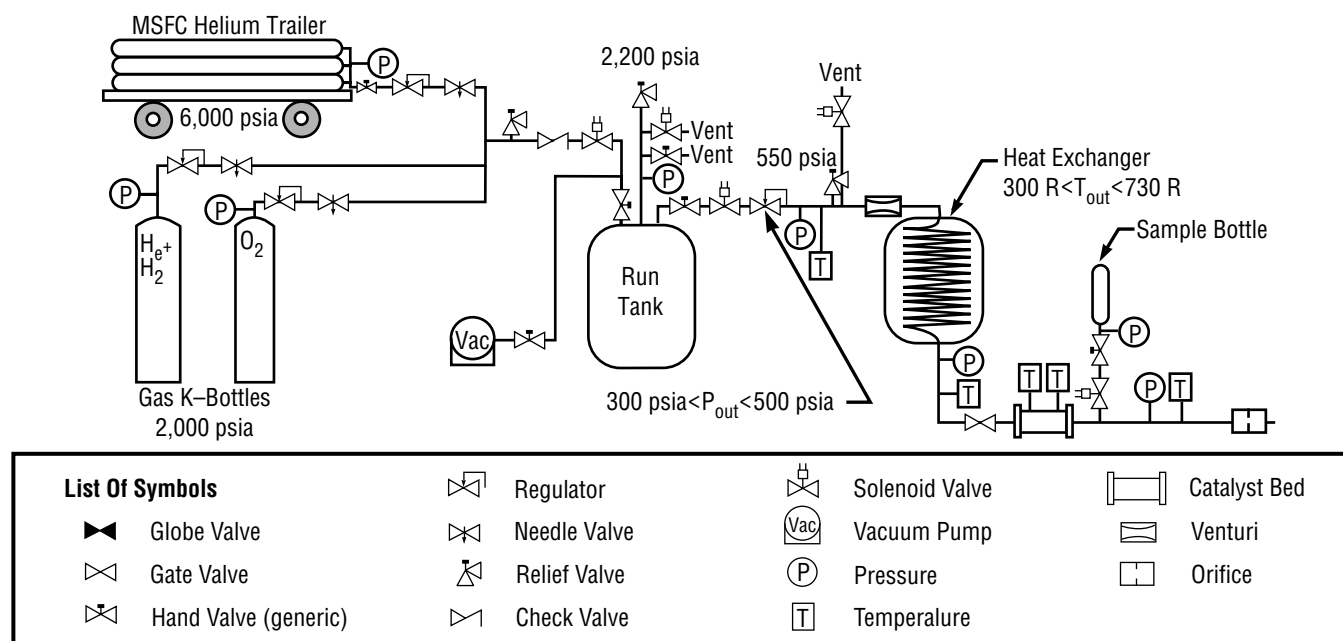


FIGURE 39.—Tridyne gas characterization fluid schematic for Test Phases I and II.

handling risk comes from the fact that Tridyne is a stable mixture and does not require some of the precautions required for hydrazine and its derivatives, which are toxic and carcinogenic.

The primary commercial application for Tridyne technology is expected to be propulsion systems for commercial launch vehicles and spacecraft, with the same mass reductions and risk mitigation described previously.

Through the test program described above, the MSFC Propulsion Laboratory is seeking to determine the Tridyne reaction rate constants to enable spacecraft designers to size Tridyne catalyst beds analytically. As this capability is developed, Tridyne should become a more readily available technology, offering the benefits of mass reductions and risk mitigation for future spacecraft propulsion systems.

¹Barber, H.E.: "Advanced Pressurization Systems Technology Program Final Report." AFRPL-TR-66-278, 1966.

²Anonymous (Rocketdyne): "Lightweight Advance Post-Boost Vehicle Propulsion Feed System." AFRPL, F04611-77-C-0068, 1977.

³Barber, H.E., et al: "Microthrusters Employing Catalytically Reacted Gas Mixtures, Tridyne." AIAA Paper no. 70-614, 1970.

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Biographical Sketch: Patrick McRight works as a liquid propulsion systems engineer in the MSFC Propulsion Laboratory. He routinely analyzes and models subsystems within main propulsion systems, troubleshoots propulsion test articles, serves as principal investigator of the Tridyne gas characterization study, and coordinates other MPS test programs. He holds a bachelor of science degree in engineering (chemical) from the University of Alabama in Huntsville (1987). ■